10.612.524

08.12.2003

INVESTOR IN PEOPLE

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed [redacted]

Dated 7 July 2003

Patents Form 1/77

Patents Act 1977
(Rule 16)

THE PATENT OFFICE
A
26 FEB 2003
RECEIVED BY FAX

The Patent Office

26FEB03 E787971-1 002824
P01/7700 0.00-0304353.6

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form).

The Patent Office

Cardiff Road
Newport
SOUTH WALES NP10 8QQ

1. Your Reference

P.7091.GBA

2. Patent application number *(The Patent Office will fill in this part)*

26 FEB 2003

0304353.6

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Cirocco Ltd
Suites 4 and 5
Neath Farm Business Park
154 Church End
Cherry Hinton
Cambridge, CB1 3LD

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

8333437001

4. Title of the invention

Flow Connector

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

MAGUIRE BOSS
5 Crown Street
St. Ives
Cambridgeshire
PE27 5EB, GB

Patents ADP number *(if you know it)*

07188725001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day/month/year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day/month/year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.)
See note (d)

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form.
Do not count copies of the same document

Continuation sheets of this form	
Description	10 ✓
Claims(s)	3 ✓ in
Abstract	
Drawing(s)	7 only ✓

10. If you are also filing any of the following, state how many against each item.
Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*

Request for preliminary examination and search *(Patents Form 9/77)*

Request for substantive examination *(Patents Form 10/77)*

Any other documents *(please specify)*

11. I/We request the grant of a patent on the basis of this application.

Signature Maguire Boss Date 26/2/3

MAGUIRE BOSS

12. Name and daytime telephone number of person to contact in the United Kingdom IAN HARTWELL Tel: 01480 301588

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

TITLE: FLOW CONNECTOR

DESCRIPTION

The present invention relates to flow connectors comprising male and female components that interlock in an axial direction thereof, particularly flow connectors of the 'dry disconnect' variety in which leakage of fluid on disconnection of the two connector components is reduced to negligible proportions or avoided completely.

Connectors of this kind are known from the tanker industry where they are used to connect flexible hoses. Rotation of a handwheel screws male and female components together in an axial direction and thereafter releases sealing valve members in both male and female components. Fluid passes around the circumference of these sealing valve members on its way from an axial inlet to an axial outlet. As will be appreciated, the resistance to flow of such an arrangement can be significant, giving rise to considerable pressure losses and increasing the necessary pumping power. The present invention has as an objective a fluid connector in which such losses are reduced.

Accordingly, the present invention consists in a flow connector comprising male and female components that interlock in an axial direction thereof; said male and female components having respective ports defining a flow path and a sealing valve member moveable in said axial direction between a first position between said ports and in said flow path in which flow between said ports is prevented, and a second position not between said ports and out of said flow path in which flow between said ports is permitted.

Positioning the sealing valve member of the connector such that it can be located out of the flow path and not between the ports avoids flow around the circumference of the sealing valve member and the corresponding pressure losses.

Advantageously, the flow path through one port is in a direction other than said axial direction, preferably predominantly in a direction normal to said axial direction.

The male component may comprise a tubular member insertable in a bore in said female member; said sealing valve member being moveable to said first position in a bore of said tubular member. Said one port may be formed in the bore in said female member, and the sealing valve member may be moveable from a first position in said bore of said tubular member to a second position in said bore in said female member, thereby to allow flow through said one port formed in said bore in said female member.

The female member may include a further sealing valve member, moveable within said bore of said female member to control flow through said one port formed in said bore in said female member. Furthermore, the sealing valve member and said further sealing valve member may each form part of respective assemblies, the further sealing valve member assembly being engageable by the sealing valve member assembly, thereby to move said further sealing valve member assembly.

In a particular embodiment, the sealing valve member may form part of a sealing valve member assembly comprising a plunger supporting said sealing valve member, said plunger being tapered in the axial direction, thereby to reduce the resistance to flow through said one port in a direction other than said axial direction. Alternatively or in addition, the sealing valve member may form part of a sealing valve member assembly comprising a further tubular member slidably arranged in said tubular member and connected by means of a flat plate to a plunger supporting said sealing valve member.

In another embodiment, the sealing valve member may form part of a sealing valve member assembly comprising a further tubular member slidably arranged in said tubular member and having a further port formed in its circumferential wall, said sealing valve member being located on said tubular member between said port and one end of the further tubular member. This further tubular member may have a bore having a first portion communicating with said further port and which lies at an angle relative to said axial direction. Advantageously, this angle is in the region of 45°, preferably exactly 45°. Furthermore, the transition between said first portion and a second portion of the bore substantially aligned with said axial direction may be configured so as to reduce flow losses.

Preferably there are substantially no cavities between said sealing valve member and said further sealing valve member when respective assemblies are engaged, thereby avoiding retention of flow after the engagement is broken. In particular, where the sealing valve member and further sealing valve member assemblies each have respectively engageable faces, said sealing valve member and further sealing valve member may be located adjacent respective faces. These faces may be flat and engage over substantially all their area, thereby avoiding retention of flow after engagement is broken.

Typically, the sealing valve member and/or said further sealing valve member are spring biased towards a position in which fluid flow is prevented.

For some applications, the bore of said female member may have a mouth for receiving said male member, and wherein the external profile of said female member tapers away in said axial direction from said region of said female member adjacent said mouth. The member may also include means for attaching said female member to the wall of a fluid channel, which means may be operable from one side only of said wall of a fluid channel, e.g. a screw thread engageable with a corresponding screw thread on said wall.

The invention also comprises individual male and female flow connectors as described above.

The invention will now be described by way of example by reference to the following diagrams, of which:

Figures 1A and B are sectional views taken along the longitudinal axes of male and female components of a first embodiment of a flow connector according to the present invention;

Figure 2 illustrates the male and female components of the first embodiment when interlocked

Figures 3A and B are detail views of the sealing valve member assembly of figures 1 and 2;

Figures 4 is a perspective view of an electronics fluid cooling system incorporating a flow connector according to the present invention;

Figures 5A and B are front and side diagrammatic views of a manifold assembly for the system of figure 4.

Figures 6A and B illustrate a flow connector according to a second embodiment of the invention in disconnected and connected configurations respectively.

Figure 1A shows the male component 1 of the connector and comprising a main body 5 housing a central sealing valve member assembly 30. Main body 5 comprises a first tubular section 28 for insertion into the female component and which is contiguous to (and preferably integral with) a wider tubular section 29. Slideably mounted within each of these two tubular sections is assembly 30, made up of a sealing valve member (O-ring 11) mounted in a groove 20 formed in a

plunger 21. This in turn is connected by means of flat plate member 22 to tubular member 23 which is formed with a conduit 24 itself connected to an axial flow port 26. By means e.g. of a flexible pipe 25 connected to assembly 30 by means of hose barb, fluid is supplied through the axial flow port 26 into a chamber 27 defined by main body 5 and assembly 30. Chamber is sealed at one end by O-ring 11 bearing against the wall of the bore of tubular section 28 and at the other end by a second O-ring 12 bearing against the wall of the bore of wider tubular section 29.

The female component of the connector is illustrated in figure 1B and comprises a housing 2 having a first bore 31 having a mouth 35 for reception of the male member 30 and, contiguous therewith, a second bore 32 in which is slidably mounted a plunger 3 sealed against the wall of bore 32 by an O ring 13. To allow flow to/from the connector, bore 32 is formed with ports 33 in a direction other than said axial direction 34, in this case normal to the axial direction. Spring 35 biases plunger 3 to a position in which flow between the holes 33 and bore 31 is prevented by the further sealing valve member, O ring 13.

Operation of the connector is illustrated in figure 2. Firstly, the main body 5 of the male component 1 is interlocked in an axial direction with the bore 31 of the female component, a fluid seal between the two components being effected by O-ring 14 bearing against the wall of bore 31. Secondly, collet 4 is moved against spring 41, initially forcing latch 42 (by means of cam surface 44) to engage with a flange 43 on the female part.

Once male and female components are securely latched together, further movement engages collet 4 with shoulder 40 of the sealing valve member assembly 30, sliding the latter inside main body 5 from the first position shown in figure 1A to the second position shown in figure 2. In this position, the plunger 21 is moved out of the male tubular member 28, allowing flow out of the male component as indicated by arrows B, and sufficiently far into the bore of the female component to allow this flow to pass through ports 33. It will also be noted that in moving to its

second position, plunger 21 engages with the corresponding plunger 3 of the female member, forcing this to move back along bore 32 and reveal ports 33.

Figure 3 details by means of arrows the flow through the sealing valve member assembly 30. Advantageously, plunger 21 is tapered in the axial direction, having a conical form as shown at 50, thereby to reduce the resistance to the transition of flow from axial as shown at 51 to perpendicular as shown at 52. Flow may also be facilitated by generally flat plate member 22 which, as shown in the detail of figure 3B, is connected to the remainder of assembly 30 across the mouth of conduit 24, thereby improving structural rigidity and alignment.

Disconnection is achieved by pushing the latch members 42 inwards so as to release catch 46, spring 44 then pulling sealing valve member assembly 30 backwards into engagement with the bore of tubular member 28, thereby preventing flow. Spring 35 similarly prevents fluid flow through female component 2. Thereafter, the latch is fully released and the connector bodies can be disengaged.

The construction of plungers 3,21 with flat end faces 7, 15 that engage over substantially all their area and O-rings 11,13 positioned adjacent (preferably as close as possible) to those end faces ensures that there are substantially no cavities in which fluid can be retained when respective assemblies are engaged, thereby reducing fluid leakage after the male and female components are disconnected to negligible proportions (just a wetted surface).

Although not restricted in its application, the present invention is particularly suited to arrangements in which the female connector member is mounted on a duct, pipe, manifold, rectangular section pipe 6, tank wall, or other surface. Such an arrangement is shown in figures 1 and 2, the female connector 2 being secured to the wall 6 of a duct by securing means such as a screw thread 34 engaging with a corresponding thread in the wall. Spanner flats may be formed on adjacent collar 45 to facilitate the screwing / tapping process. Preferably, the securing means are configured and the elements of the female member sized so as to facilitate

installation of the female member from one side only of the wall, a measure particularly important wherever there is no means of access to the other side of the wall.

A particularly preferred application is in ducts where there is flow transverse to the axis of the connector (as indicated by arrows 16 in figure 2). To minimise the resistance to flow in the duct presented by the female member, that part of the female member protruding into the duct is made as slim as possible. This results in an overall shape of the female member that tapers in an axial direction away from its mouth 35.

Such a preferred implementation is known from co-pending UK patent application number 0204583 (incorporated herein by reference). Referring to figure 4, this application discloses an electronics fluid cooling system 69 according to the present invention when incorporated into a conventional server rack 61. Mounted in the rack are electronic apparatus 62 (e.g. server, computer, storage device) each of which has a local cooling circuit discussed in more detail below.

Each local cooling circuit is connected by means of pipes 63 to a 'global' cooling circuit 4 comprising a manifold assembly 65 arranged vertically within the side or back panel of the rack and an external radiator / heat exchanger 68. Hot fluid from the local cooling circuits is fed to the heat exchanger 68 and heat transferred to a heat sink (typically the atmosphere, alternatively a chilled water supply) by means of pipes 66. Cooled fluid then returns to a control unit 67 located at the base of the rack and housing a pump for feeding fluid between back to the manifold assembly 65.

As will be evident from the front and side schematic views of figures 5A and 5B, manifold assembly 65 comprises two individual manifolds or aisles 70, 71. Cold aisle 60 is fed with cold fluid (fluid at a lower temperature than the components it is cooling) from control unit 67 via a pipe 72. The cold aisle 72 is in turn connected in parallel via pipes 73 to each electronic equipment 62 and cold fluid is distributed

between them. After passing through each equipment 62, the fluid is then directed back to hot aisle 71 and thence (via pipe 74) to control unit 67. From here, the fluid is piped to the fluid inlet of an external radiator 68 to lower the temperature back to cold levels. The fluid then exits the radiator via a fluid outlet, returning to the control unit and passing around the system again. The connections allow electronic equipment to be connected to the manifold via pipes. An electronic equipment is connected to both the cold aisle and the hot aisle. Advantageously, each manifold 70,71 is equipped at its top end with an air release device to remove unwanted air. Alternatively or in addition, the fluid circuit may be operated at a pressure below atmospheric. In the event that the circuit is punctured, this ensures that air is sucked into the circuit rather than fluid leaking out. The release device allows such air to be bled from the circuit.

Flow connectors according to the present invention are shown at 75. Connecting the global fluid circuit 64 and particularly the manifold aisles 70,71 to fluid circuits in respective electronic equipment 62, they provide repeatably-connectable, self-sealing connections which allow individual electronic apparatus to be removed from the rack and other apparatus to be installed in its place. Furthermore, the self-sealing nature of the connection allows this to be achieved without the risk of fluid leakage that would otherwise necessitate a shut down of the entire cooling system whenever an electronic unit was to be replaced. Advantageously, a touch sensor may be embedded in the tip of the plunger of the flow connector, indicating when a connection is made or broken. This in turn will indicate to a control unit how may individual electronic apparatus, e.g. servers, are plugged into the fluid supply at any given time.

Figures 6A and B illustrate a flow connector according to a second embodiment of the invention in disconnected and connected configurations respectively, those elements common with the first embodiment being designated by the same reference figures as used to describe the first embodiment.

Referring to figure 6A, the male component 1 of the connector comprises a first tubular section 28 for insertion into the female component. Slideably mounted within tubular section 28 is assembly 30 made up of a sealing valve member (O-ring

11) mounted in a groove formed at the end of further tubular member 100. Member 100 is formed with a bore 24 having straight and angled portions 101 and 102. Straight bore portion 101 communicates at one end with an axial flow port 26 for connection e.g. to a flexible fluid pipe (not shown) by means of screw thread 103. Angled bore portion 102 on the other hand communicates with a port 105 formed in the circumferential wall 110 of member 100.

Female connector component comprises a housing 2 having a bore 31 for reception of the tubular section 28 and in which is slidably mounted a plunger 3 sealed against the wall of the bore 31 by an O ring 13. To allow flow to/from the connector, bore 31 has formed in its wall a port 120 communicating with flow port 130 arranged at an angle theta to the axial direction. This may also be equipped with a screw thread (not shown) for attachment e.g. to a flexible fluid pipe. Spring 35 biases plunger 3 to a position in which flow through port 120 is prevented and is held inside housing 2 by means of an end cap 140 attached e.g. by a screw thread 150.

Operation of the second embodiment of the connector is illustrated in figure 6B. Application of force, e.g. manually, initially forces tubular section 28 of the male component 1 into the bore 31 of the female component 2, a fluid seal between the two components being effected by O-ring 14 bearing against outer surface of tubular section 28. Thereafter, tubular member 100 is pushed into bore 31, disengaging O-ring 11 from its seat in the port 200 of the tubular section 28. Face 7 of member 100 also engages the face 15 of plunger 3 and together the two elements 28,3 move to a position to the right-hand side of figure 6B in which neither sealing member nor plunger 3 obstructs the flow path 190 between ports 200 and 120 in female member 2. Male and female members are then held in releasable engagement by latch mechanism 170 of the kind well known in the art and consequently not disclosed in any greater detail here.

As with the first embodiment of the invention, the positioning of sealing member 11 out of the flow path 190 facilitates flow. However, the smooth flow path of the second embodiment allows yet further reduction in flow pressure losses, particularly when suitable surface finish, bend angle (theta) and bend radius of the angled portion 102 of bore 24 is chosen. In this regard, angles in the region of 45°

have been found to offer a good compromise between commercially-acceptable connector length and connector performance, with angles of exactly 45° having the further advantage of being compatible with conventional pipe fittings. However, in the limit, angles as high as 90° can be used. Alternatively or in addition, good connector performance may be obtained using a ratio of bend radius to bore diameter of substantially 1.5.

The improved pressure loss characteristics of connectors according to the present invention permit a higher flow or a smaller connector for the same pump power. Connectors of small cross-sectional area also retain less fluid on disconnection, reducing spillage. In addition, the larger bore of the second embodiment reduces the likelihood of blockage from grit, lumps or particulates as well as clogging in the case of glues and paints. The smooth bore of the second embodiment also reduces flow turbulence, important in applications involving beer and aviation fuel, for example.

It should be understood that this invention has been described by way of examples only and that a wide variety of modifications can be made without departing from the scope of the invention as defined by the claims. In particular, the invention is not restricted to the predominantly radial flow directions shown in the example.

CLAIMS

1. Flow connector comprising male and female components that interlock in an axial direction thereof; said male and female components having respective ports defining a flow path and a sealing valve member moveable in said axial direction between a first position between said ports and in said flow path in which flow between said ports is prevented, and a second position not between said ports and out of said flow path in which flow between said ports is permitted.

2. Flow connector according to claim 1, wherein the flow path through one port is in a direction other than said axial direction.

3. Flow connector according to claim 2 wherein said flow path through said one port is predominantly in a direction normal to said axial direction.

4. Flow connector according to any one of claims 1 to 3, wherein said male component comprises a tubular member insertable in a bore in said female member; said sealing valve member being moveable to said first position in a bore of said tubular member.

5. Flow connector according to any one of claims 1 to 4, wherein said one port is formed in said bore in said female member.

6. Flow connector according to claim 5, wherein said sealing valve member is moveable from a first position in said bore of said tubular member to a second position in said bore in said female member, thereby to allow flow through said one port formed in said bore in said female member.

7. Flow connector according to claim 6, wherein said female member includes a further sealing valve member, moveable within said bore of said female member to control flow through said one port formed in said bore in said female member.

8. Flow connector according to claim 7 when dependent on claim 6, wherein said sealing valve member and said further sealing valve member each form part of respective assemblies, the further sealing valve member assembly being engageable by the sealing valve member assembly, thereby to move said further sealing valve member assembly.

9. Flow connector according to any preceding claim, wherein said sealing valve member forms part of a sealing valve member assembly comprising a plunger supporting said sealing valve member, said plunger being tapered in the axial direction, thereby to reduce the resistance to flow through said one port in a direction other than said axial direction.

10. Flow connector according to any preceding claim, wherein said sealing valve member forms part of a sealing valve member assembly comprising a further tubular member slidably arranged in said tubular member and connected by means of a flat plate to a plunger supporting said sealing valve member.

11. Flow connector according to any one of claims 1 to 8, wherein said sealing valve member forms part of a sealing valve member assembly comprising a further tubular member slidably arranged in said tubular member and having a further port formed in its circumferential wall, said sealing valve member being located on said tubular member between said port and one end of the further tubular member.

12. Flow connector according to claim 11, wherein said further tubular member has a bore having a first portion communicating with said further port and which lies at an angle relative to said axial direction.

13. Flow connector according to claim 12, wherein said angle is in the region of 45°.

14. Flow connector according to claim 13, wherein said angle is 45°.

15. Flow connector according to any one of claims 12 to 14, wherein the bore of said further tubular member has a second portion substantially aligned with said axial direction, the transition between said first and second portions being configured so as to reduce flow losses.

16. Flow connector according to claim 8 to 15, wherein there are substantially no cavities between said sealing valve member and said further sealing valve member when respective assemblies are engaged, thereby avoiding retention of flow after the engagement is broken.

17. Flow connector according to claim 16, wherein said sealing valve member and further sealing valve member assemblies each have respectively engageable faces, said sealing valve member and further sealing valve member being located adjacent respective faces.

18. Flow connector according to claim 16 or claim 17, wherein said respectively engageable faces are flat and engage over substantially all their area, thereby avoiding retention of flow after engagement is broken.

19. Flow connector according to any preceding claim, wherein said sealing valve member and/or said further sealing valve member is spring biased towards a position in which fluid flow is prevented.

20. Flow connector according to any preceding claim, wherein the bore of said female member has a mouth for receiving said male member, and wherein the external profile of said female member tapers away in said axial direction from said region of said female member adjacent said mouth.

21. Flow connector according to any preceding claim, wherein said female member includes means for attaching said female member to the wall of a fluid channel.

22. Flow connector according to claim 21, wherein said means are operable from one side only of said wall of a fluid channel.

23. Flow connector according to claim 22, wherein said means for attaching said female member to the wall of a fluid channel is a screw thread engageable with a corresponding screw thread on said wall.

24. Male flow connector component of a flow connector according to any of claims 1 to 23.

25. Female flow connector component of a flow connector according to any of claims 1 to 23.

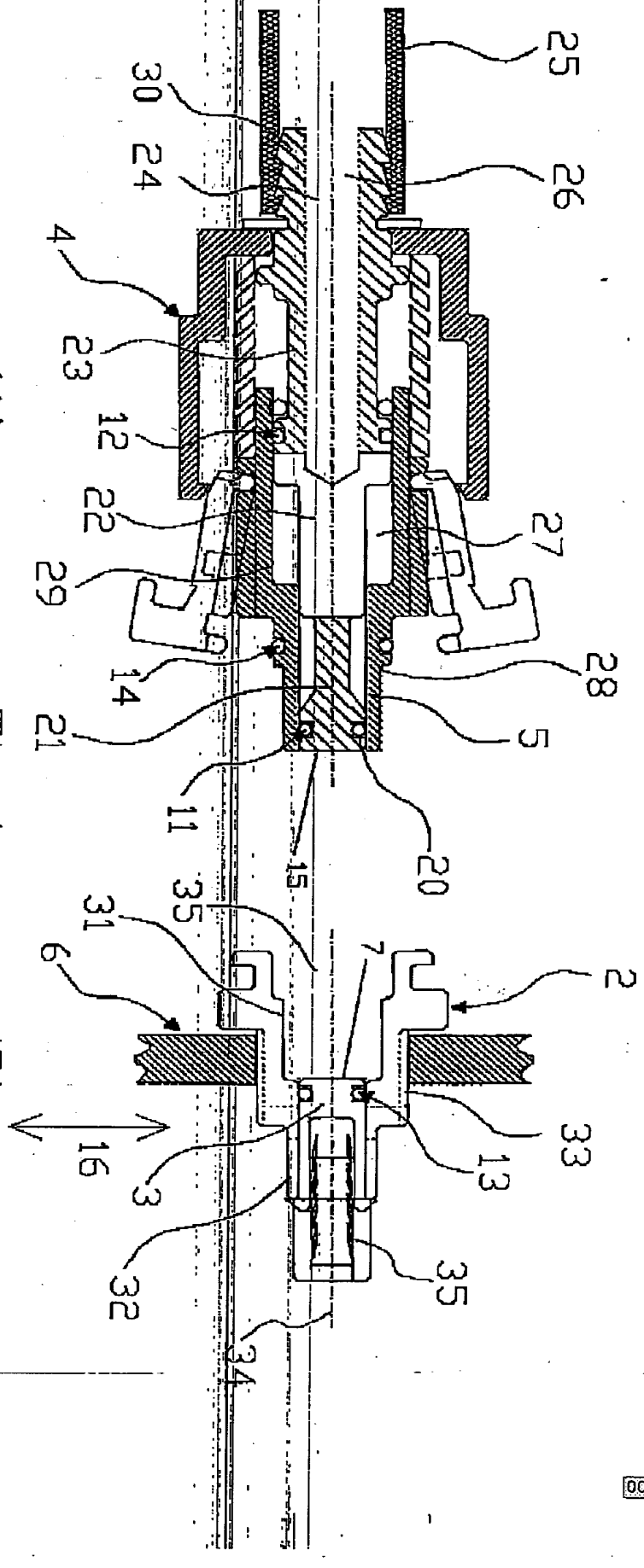

Fig 1

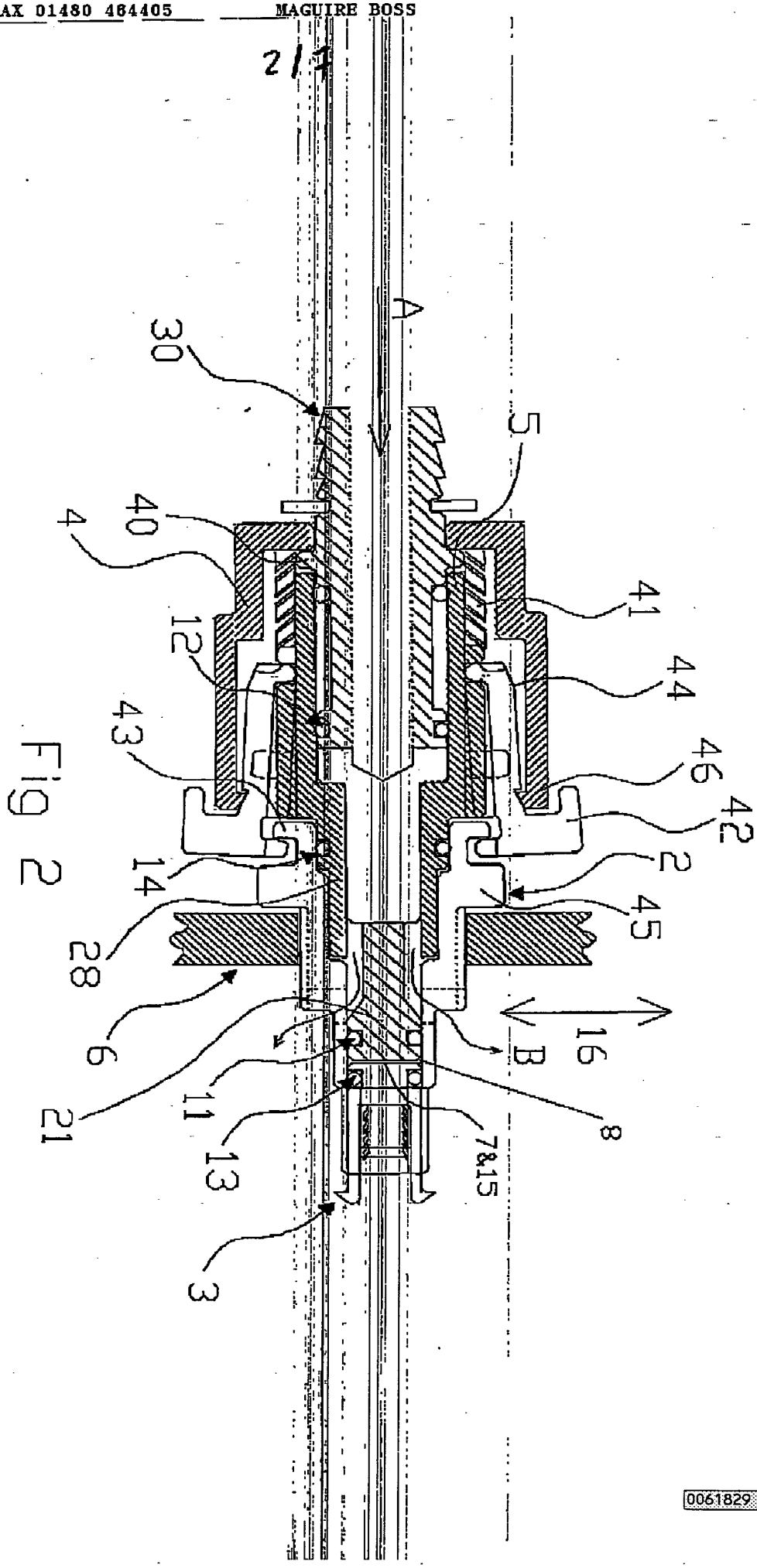

Fig 2

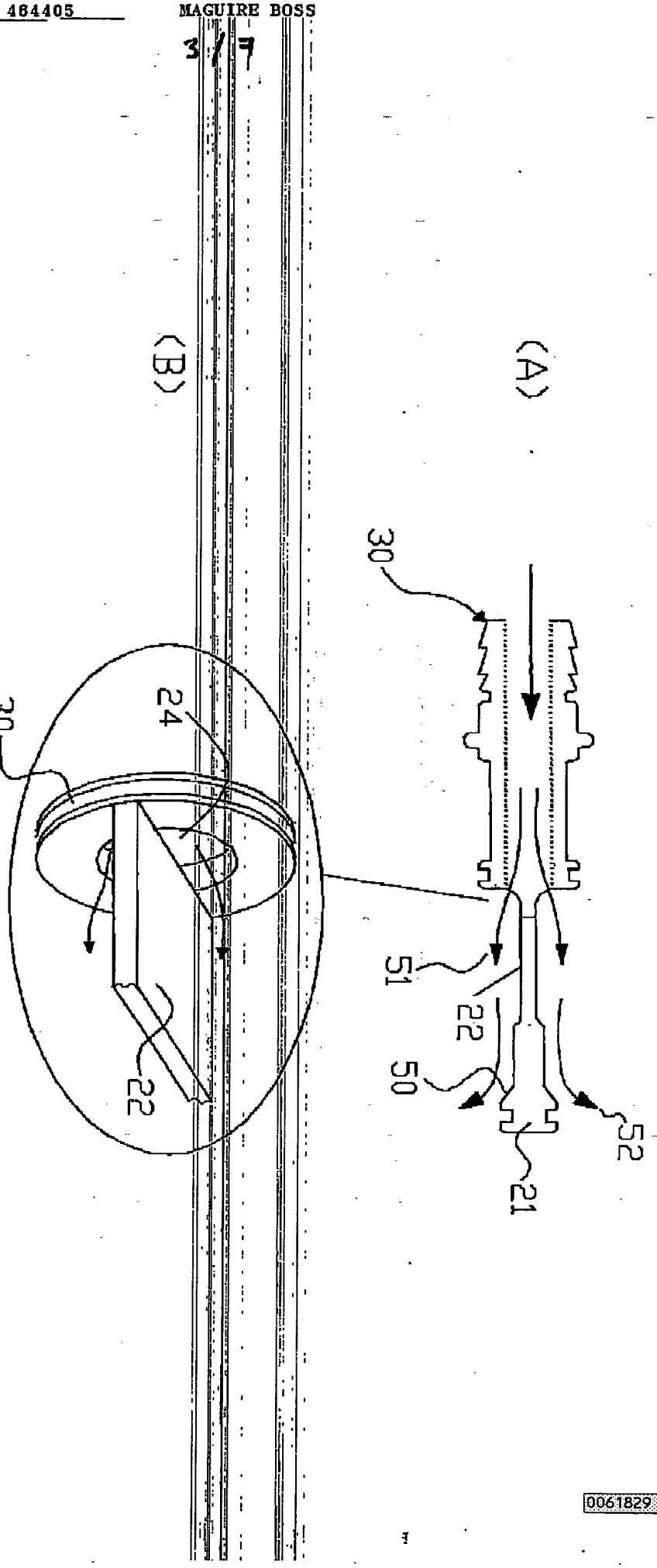

Fig 3

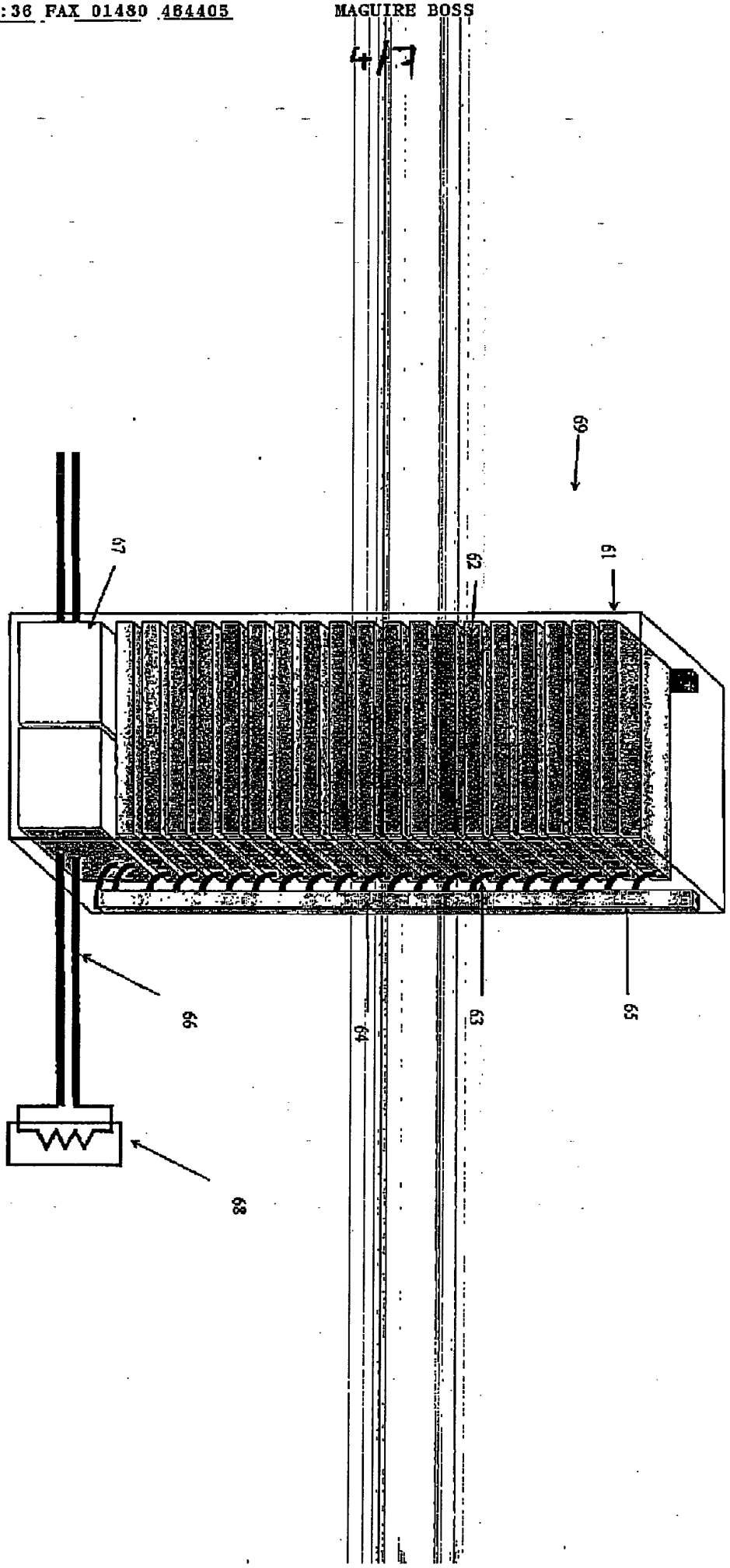

Fig4

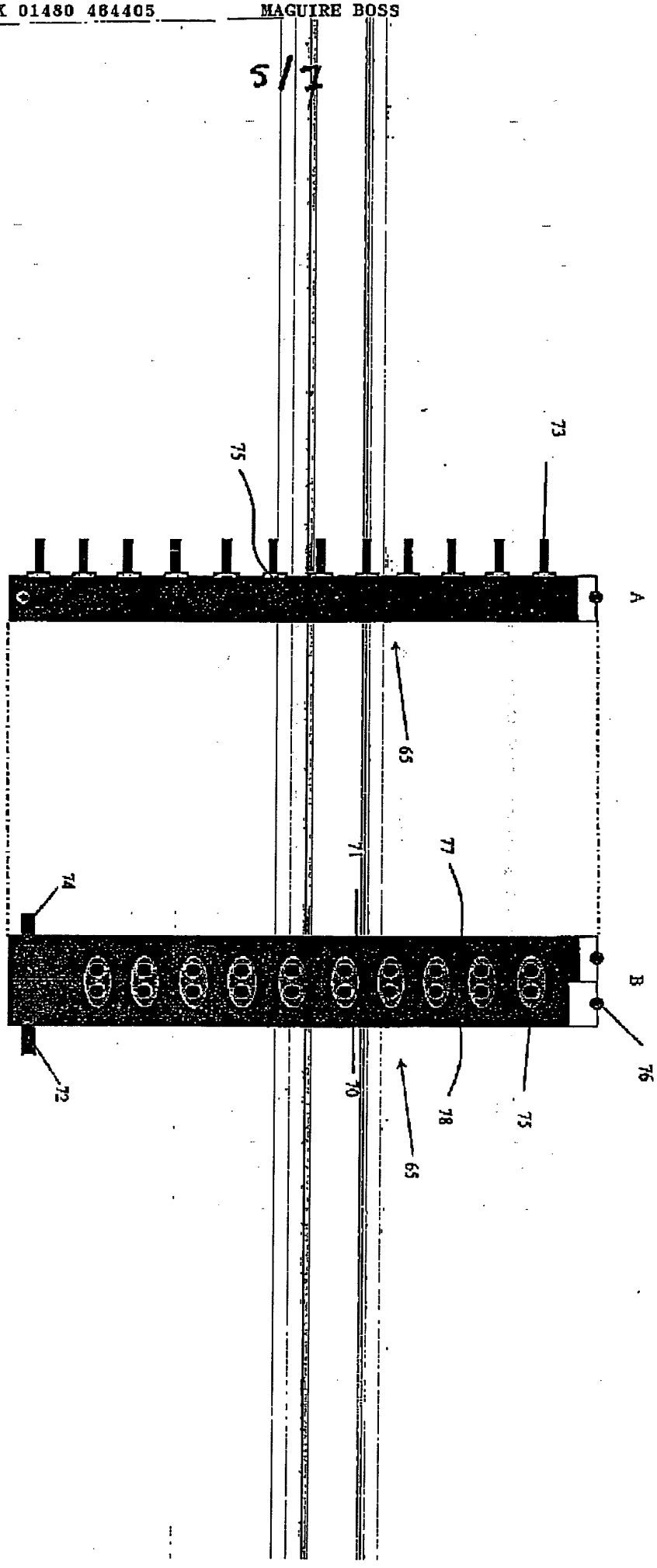

Fig 5

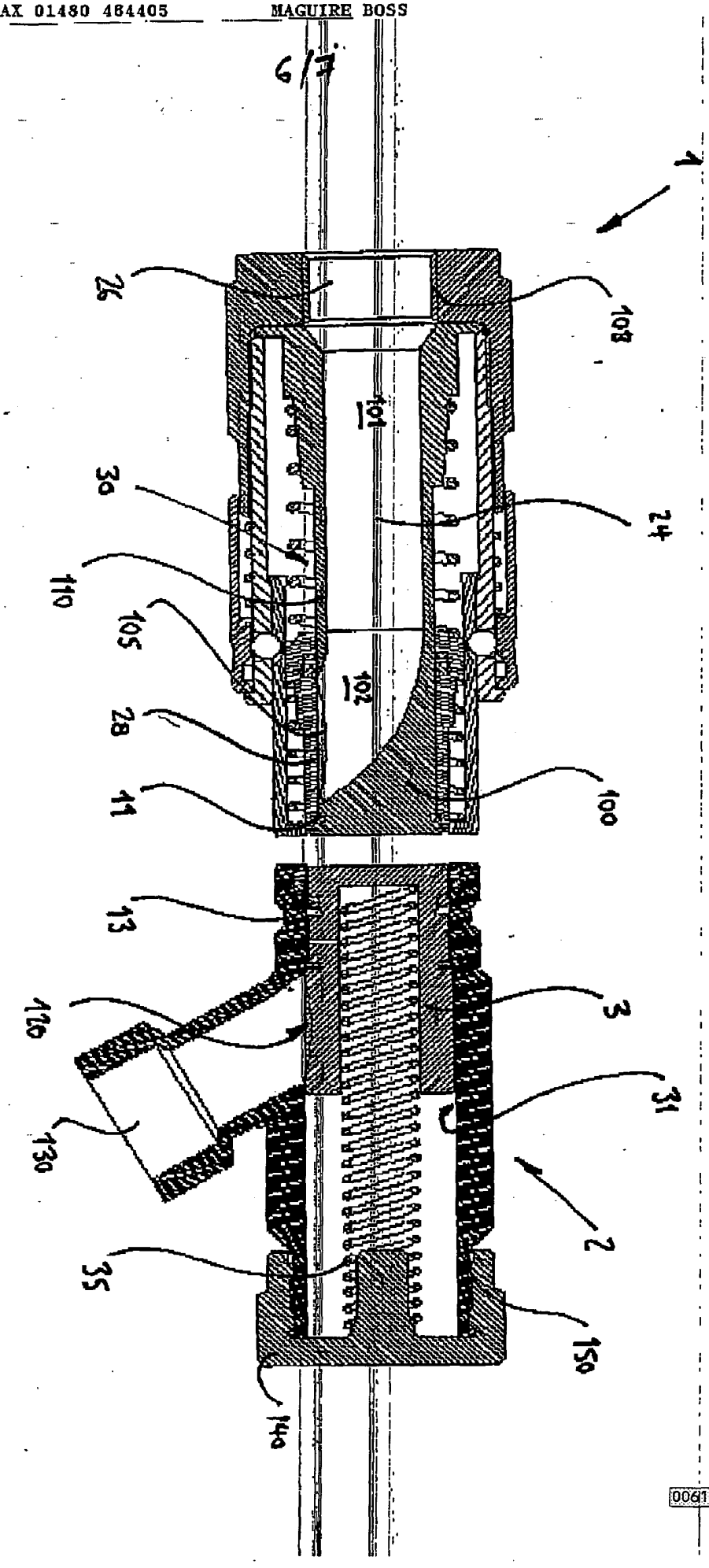

FIG. 6A

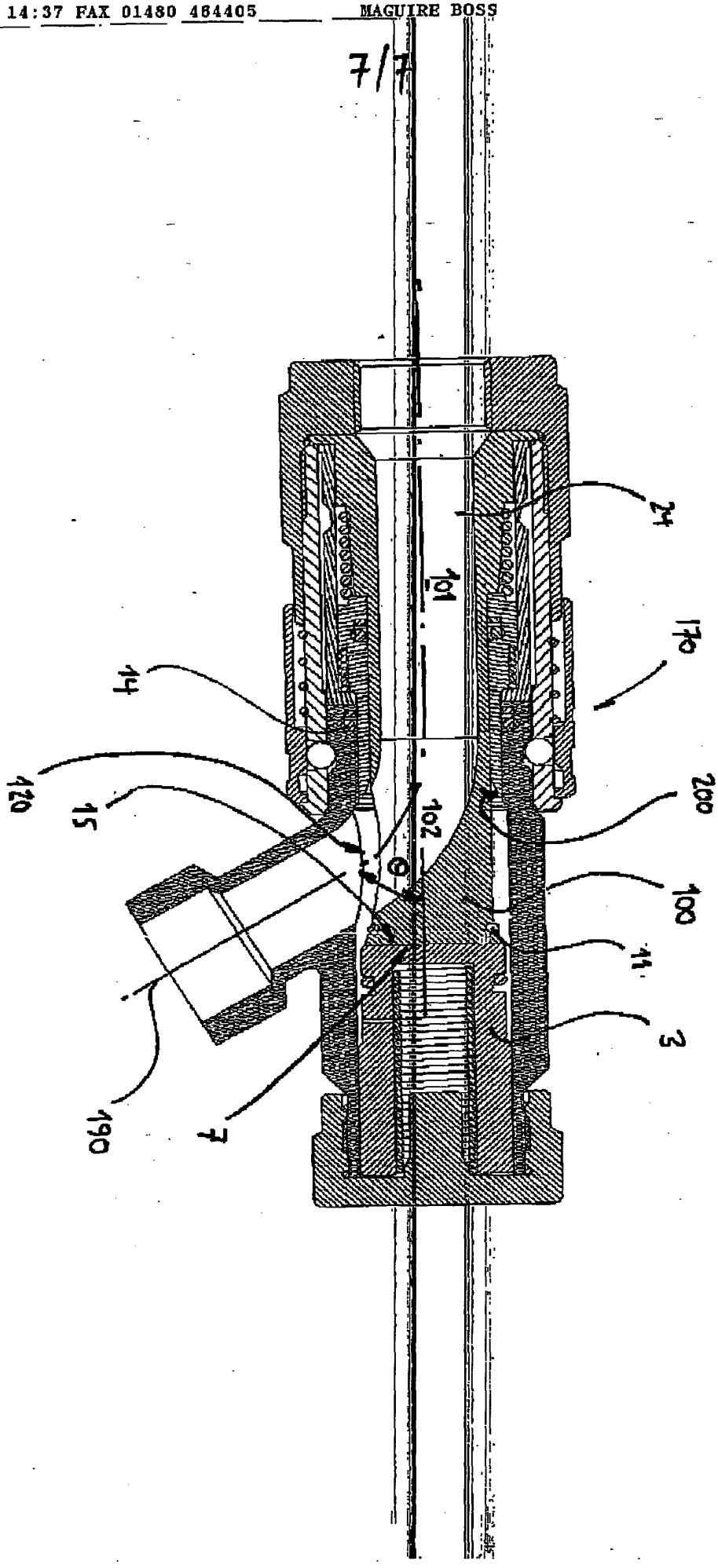

FIG. 6B